

Calibration Report: Absolute Cavity Radiometers S.N. 31041 and 31105

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SUMMARY

Calibration date: 2003 September 24.

Next calibration due: 2004 September 24.

Calibrations of two Absolute Cavity Radiometers have been completed. The World Radiation References (WRRs) and associated uncertainties with respect to SI units (U95%) are as follows:

Absolute Cavity Radiometer	Controller	WRR	U95%
31041	34970A	0.99743	0.34
31105	34970A	1.00309	0.34

Application:

$$I = WRR*(I_o) \pm U95\%$$

Where:

I = WRR corrected irradiance, Watt/meter².

I_o = Irradiance output of the cavity-controller system, Watt/meter².

U95% = the 95 % confidence interval.

Calibration certificates from the National Renewable Energy Laboratory located in Golden Colorado are included in this document.

DISCUSSION

Calibration data from Absolute Cavity Radiometers were collected at NREL in September 2003. The serial numbers of these sensors are 31041 and 31105. The calibration standards used were those used at NREL, a list of them is included with this document. These calibration data were analyzed to produce a new World Radiation Reference (WRR) factor and 95-percent uncertainty bound (U95), WRT SI units, for each radiometer. These coefficients are compared to prior calibration results. The instrument setup, data collection, data analysis and uncertainty calculation are as reported in the NPC2001 reference. NREL supplied calibration documents are included.

CALIBRATION HISTORIES

	Month /day	Test Cavity Serial Number	Controller	WRR	U95% WRT SI
NPC2003	9/24	31041	34970A	0.99743	0.34
NPC2002	9/27	31041	34970A	0.99785	0.34
NPC2001		31041	34970A	0.99793	0.33
NPC2001		31041	406	0.99830	0.35
IPC-IX (2000)		31041	406	0.99799	0.55
NPC1999		31041	406	0.99827	0.39
NPC1998		31041	406	0.99833	0.37
NPC1997		31041	406	0.99961	0.42
NPC2002	9/24	31105	34970A	1.00309	0.34
NPC2002	9/27	31105	34970A	1.00357	0.35
NPC2001		31105	34970A	1.00327	0.34

Calibrations labeled NPC year took place at the National Renewable Energy Laboratory in Golden, Colorado. Calibrations labeled IPC took place at the World Radiation Center in Davos, Switzerland. All calibrations take place during the September-October time frame of their respective years.

National Renewable Energy Laboratory Solar Radiation Research Laboratory

Metrology Laboratory

Calibration Certificate for Absolute Cavity Radiometer

NREL Pyrheliometer Comparisons, NPC-2003

Organization: NASA/LARC-AS&M

Model Number: AHF

Control Unit Serial Number: SG41001207

Heater Resistance: 155.0 Ω

Lead Resistance: 0.066 Ω

Shunt Resistance: 1 Ω

Thermistor Coefficients: 0.0010295, 0.0002391, and 0.0000001568

Calibration Date: 09/24/2003

Environmental Conditions: (see attached Figures)

Procedure: NREL/TP-463-20619

Operator Name: Fred Denn

Serial Number: 31041

Manufacturer Cal. Factor: 1.99992

Default Sensitivity: 0.0105 $\mu\text{v}/\text{W}/\text{cm}^2$

Circuit Resistance: 4.18 Ω

Standards Used:

Serial Number	Operator	WRR*	Calibration Date	Due Date
AHF28553	Nelson	0.99733	October, 2000 *	October, 2005
AHF14915	Hickey	1.00026	October, 2000 *	October, 2005
AHF28968	Reda	0.99866	October, 2000 *	October, 2005
AHF29220	Reda	0.99846	October, 2000 *	October, 2005
AHF30713	Reda	0.99861	October, 2000 *	October, 2005
TMI67502	Nelson	0.99966	October, 2000 *	October, 2005
TMI68018	Reda	0.99848	October, 2000 *	October, 2005

* Ninth International Pyrheliometer Comparisons (IPC-IX), PMOD, Davos, Switzerland

Results with traceability to the World Radiometric Reference (WRR):

- WRR Transfer Factor (WRR-TF) : 0.99743
- Uncertainty, U_{95} : 0.34 %
- Coverage Factor : 2

Data Analysis by : Ibrahim Reda

Signature : *I. Reda*

Date : 10/02/2003

QA by : Tom Stoffel

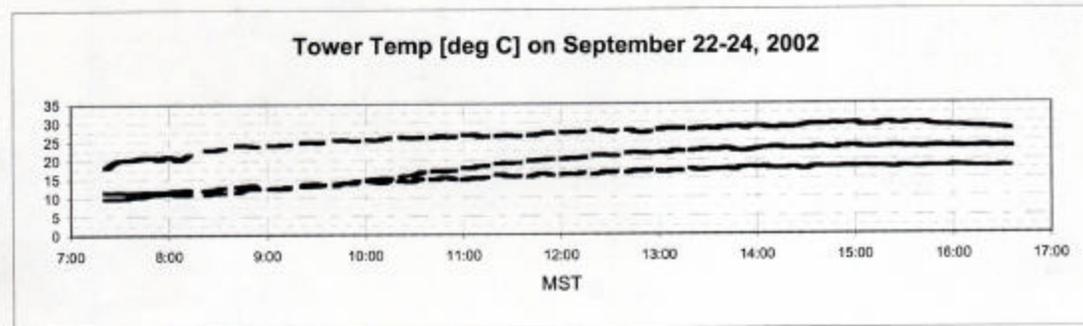
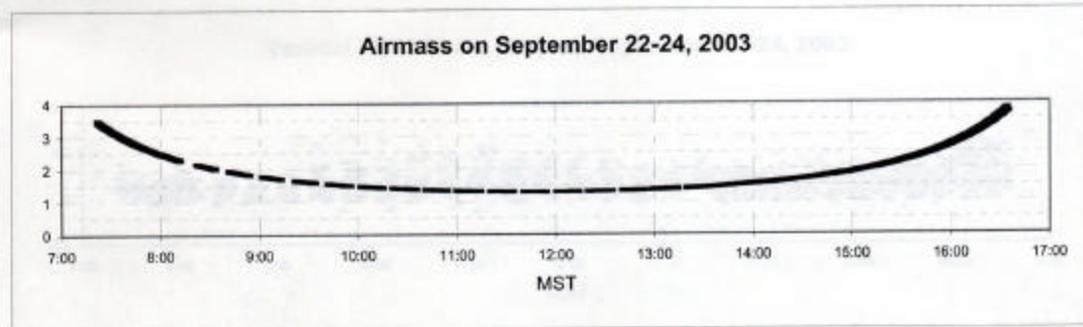
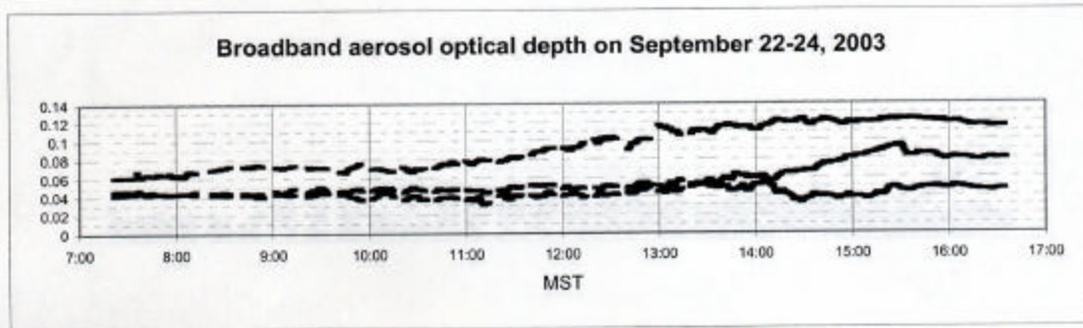
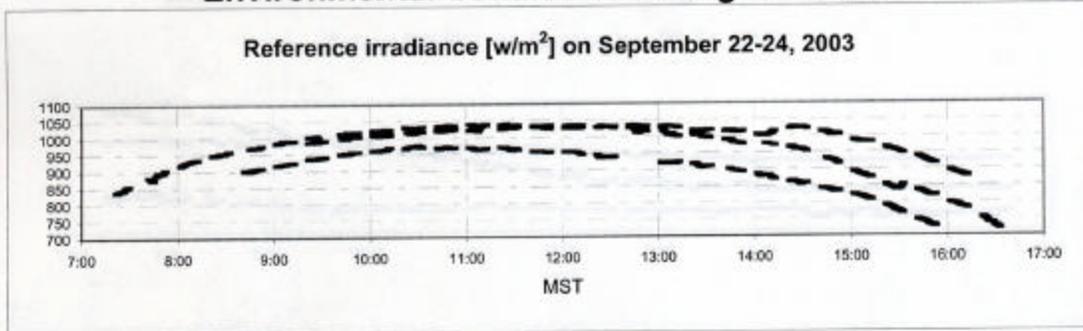
Signature : *Tom Stoffel*

Date : 10/02/2003

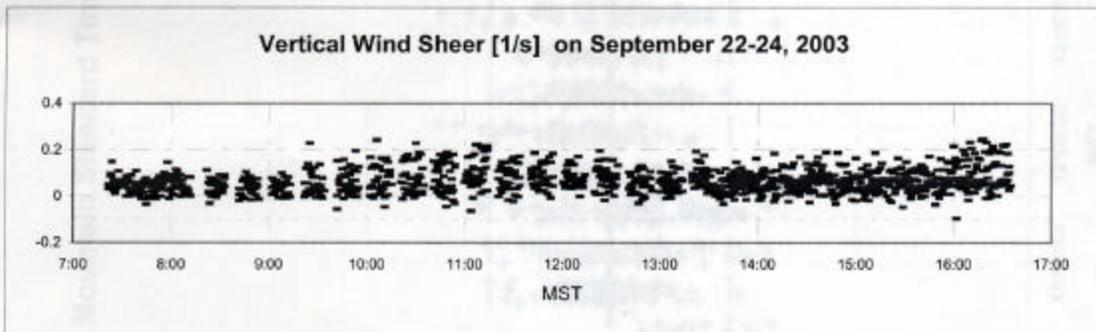
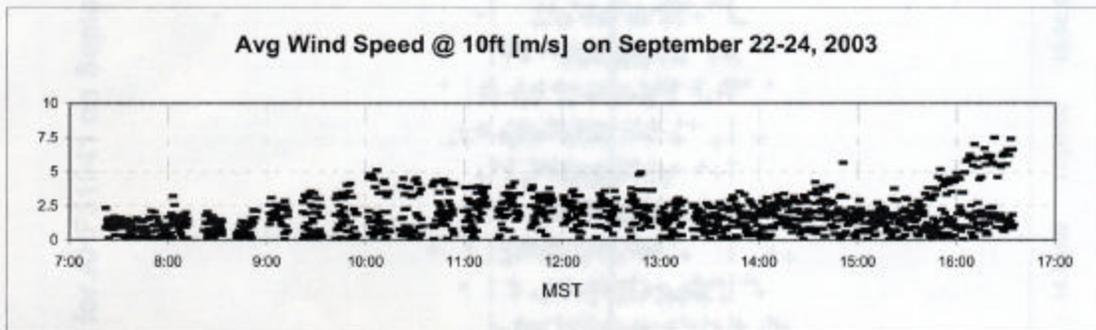
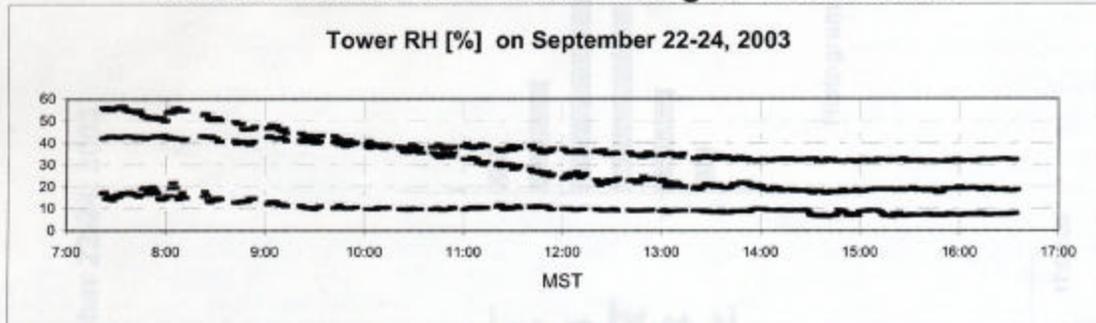
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Environmental Conditions During NPC-2003



Environmental Conditions During NPC-2003-cont.



National Renewable Energy Laboratory

Solar Radiation Research Laboratory

Metrology Laboratory

Calibration Certificate for Absolute Cavity Radiometer

NREL Pyrheliometer Comparisons, NPC-2003

Organization: NASA/LARC-AS&M

Operator Name: Fred Denn

Model Number: AHF

Serial Number: 31105

Control Unit Serial Number: US37030621

Manufacturer Cal. Factor: 1.9989

Heater Resistance: 155.4 Ω

Default Sensitivity: 0.0105 $\mu\text{v}/\text{W}/\text{cm}^2$

Lead Resistance: 0.066 Ω

Circuit Resistance: 2.55 Ω

Shunt Resistance: 1 Ω

Thermistor Coefficients: 0.0010295, 0.0002391, and 0.0000001568

Calibration Date: 09/24/2003

Due Date: 09/24/2004

Environmental Conditions: (see attached Figures)

Procedure: NREL/TP-463-20619

Standards Used:

Serial Number	Operator	WRR*	Calibration Date	Due Date
AHF28553	Nelson	0.99733	October, 2000 *	October, 2005
AHF14915	Hickey	1.00026	October, 2000 *	October, 2005
AHF28968	Reda	0.99866	October, 2000 *	October, 2005
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TMI68018	Reda	0.99848	October, 2000 *	October, 2005

* Ninth International Pyrheliometer Comparisons (IPC-IX), PMOD, Davos, Switzerland

Results with traceability to the World Radiometric Reference (WRR):

- **WRR Transfer Factor (WRR-TF)** : 1.00309
- **Uncertainty, U_{95}** : 0.34 %
- **Coverage Factor** : 2

Data Analysis by : Ibrahim Reda

QA by : Tom Stoffel

Signature : *I. Reda*

Signature : *Tom Stoffel*

Date : 10/02/2003

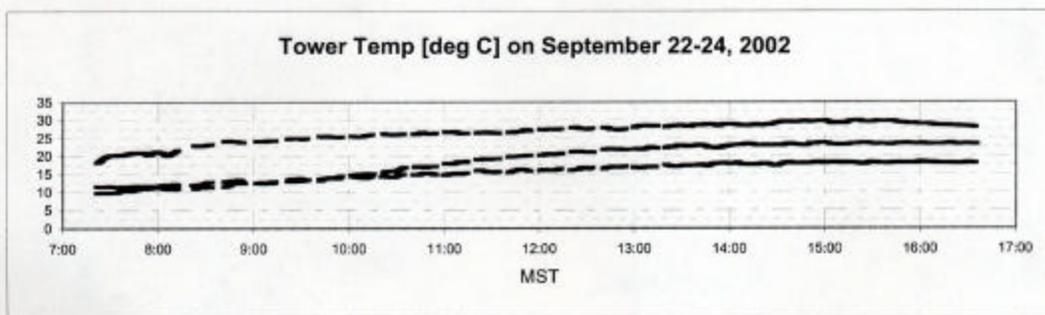
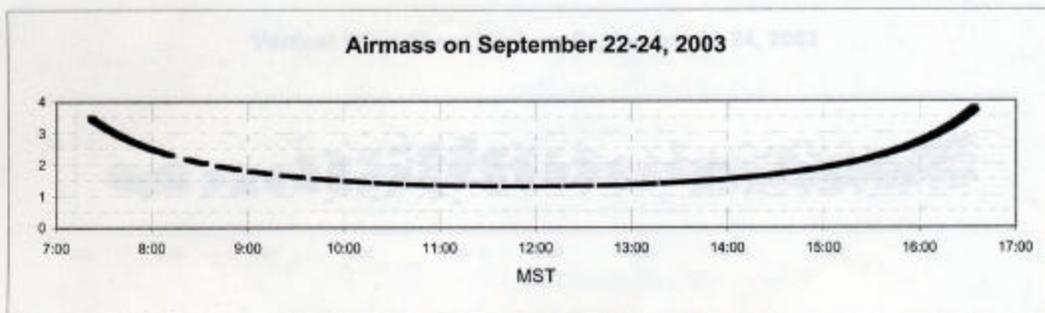
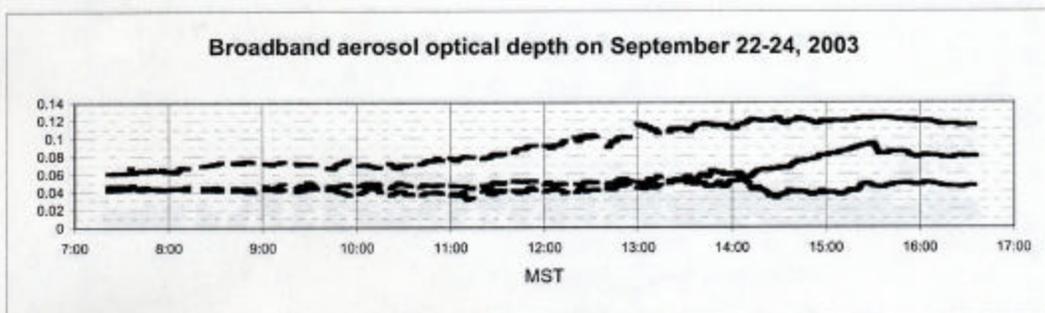
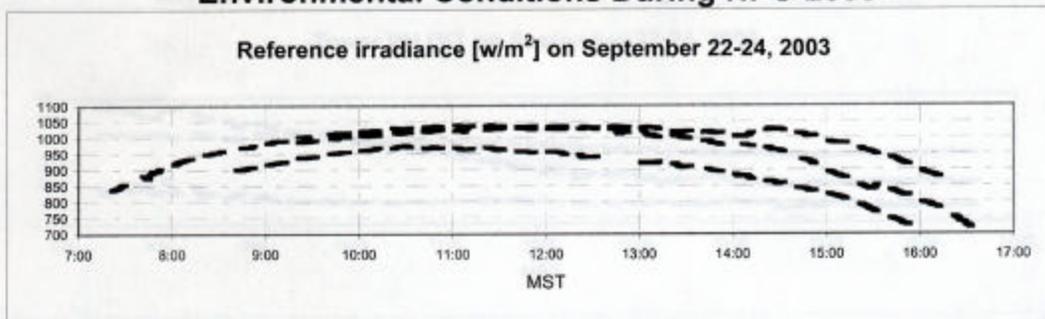
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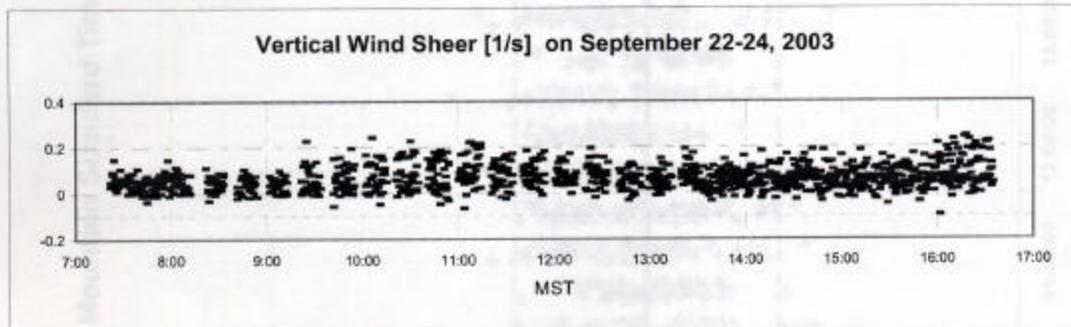
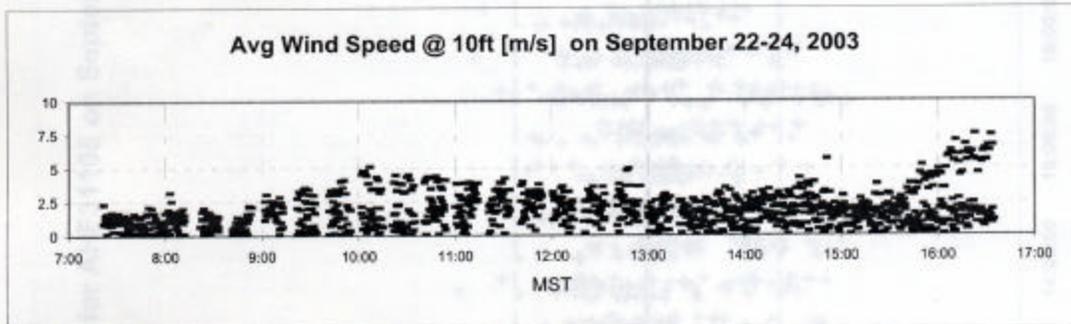
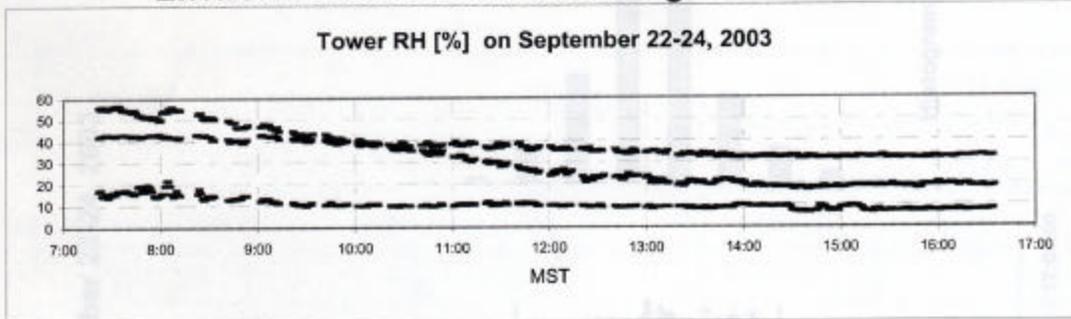
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Environmental Conditions During NPC-2003



Environmental Conditions During NPC-2003-cont.



REFERENCES

- Reda, I., Stoffel, T., “Results of NREL Pyrheliometer Comparisons NPC2001”, National Renewable Energy Laboratory, Center for Renewable Energy Resources, Measurements & Instrumentation Team, 2001.
- Swiss Meteorological Institute, (May 2001). “International Pyrheliometer Comparison IPC-IX.” Working Report No. 197, Davos and Zurich.
- Reda, I., Stoffel, Wilcox, S., “Results of NREL Pyrheliometer Comparisons NPC1999”, National Renewable Energy Laboratory, Center for Renewable Energy Resources, Measurements & Instrumentation Team, 21 September 1999.
- Reda, I., Stoffel, T., Treadwell, J., “Results of NREL Pyrheliometer Comparisons NPC1998”, National Renewable Energy Laboratory, Center for Renewable Energy Resources, Measurements & Instrumentation Team, 11 November 1998.
- Reda, I., Stoffel, T., Treadwell, J., “Results of NREL Pyrheliometer Comparisons NPC1997”, National Renewable Energy Laboratory, Center for Renewable Energy Resources, Measurements & Instrumentation Team, 11 November 1997.
- Reda, Ibrahim, Stoffel, Tom, “Results of the NREL Pyrheliometer Comparisons NPC1996, 1-5 October 1996”, National Renewable Energy Laboratory, Renewable Energy Resources Center, Measurements and Instrumentation Team.